

## RESEARCH ARTICLE

# Biomechanical Aetiology of the So-called Adolescent Idiopathic Scoliosis (AIS). Lublin Classification (1995-2007). Causative Influences Connected with “Gait” and “Standing ‘at ease’ on the Right Leg”

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## Abstract

The biomechanical etiology of the so-called idiopathic scoliosis [adolescent idiopathic scoliosis (AIS)] was the subject of research of author from 1984 (scholarship in Invalid Foundation Hospital in Helsinki) and over years in Poland (1984-2018). The basic observation comes from the years 1995-2007. The results of research were presented from 1995 in many Congresses and Symposia mostly abroad. First lecture was presented in Orthopedic Congress in Hungary (Szeged, 1995). First publication was in Germany in 1996 – in the journal Orthopädische Praxis.

In presented article is explained in details the biomechanical etiology of the so-called idiopathic scoliosis, new classification and rules of causal prophylaxis and new treatment.

**Keywords:** So-Called Idiopathic Scoliosis; Aetiology; Biomechanics; Classification; Rules of Causal Prophylaxis and Therapy

## Introduction

Over many years the etiology of the so-called idiopathic scoliosis (AIS) was unknown. As hypothetic factors were mentioned: genetic and hormonal factors, growth abnormalities, neuromuscular influences, disorders in growth of bones, disorders in muscle and fibrous tissue and plenty of other causes, never confirmed [1-23]. Also the experiments on animals never had to explain the etiology of scoliosis (Szendroi Miklos).

The article describes the biomechanical etiology of the so-called idiopathic scoliosis (1995-2007), known as an adolescent idiopathic scoliosis (AIS). To the present conclusion of research conducted / leded the first observation of the children with scoliosis in 1984 in Orthopedic University Department (Invalid Foundation Hospital) in Helsinki and next observations till 2018. In all cases of scoliosis I could confirm the etiological factors of “standing ‘at ease’ on the right leg” and “gait”. The described in 2006 “model of hips movement” inform about the type of scoliosis in context of adequate rage of movement of right and left hip (Table 1).

	Influence on spine as a causative factor	Character of Scoliosis	Model of right hip movement	Model of left hip movement	Curves Gibbous	Progression	Therapy Prophylaxis
Scoliosis “S” I epg	Standing on the right leg and walking	Stiff spine	Adduction 0 or (-) 5 or (-) 10 degrees	Adduction from 30 to 50 degrees	Two curves & Gibbous	Progression	Recovering of right hip movements. Flexion exercises for spine. Standing on the left leg
Scoliosis “C” II/A epg	Standing on the right leg	Flexible spine	Adduction from 20 to 30 degrees	Adduction from 30 to 50 degrees	One curve	No Progression	Flexion exercises for spine. Standing on the left leg

	Influence on spine as a causative factor	Character of Scoliosis	Model of right hip movement	Model of left hip movement	Curves Gibbous	Progression	Therapy Prophylaxis
Scoliosis "S" II/B epg	Standing on the right leg + laxity & former bad therapy	Flexible spine	Adduction from 20 to 30 degrees	Adduction from 30 to 50 degrees	Two curves & Gibbous slight	No Progression	Flexion exercises for spine. Standing on the left leg
Scoliosis "I" III epg	Walking	Stiff spine	Adduction 0 or (-) or (-) 10 degrees	Adduction from 20 to 0 degrees	No curves or very slight	No included to scoliosis till 1995-2007	Flexion exercises for spine. Standing on the left leg

Table 1: Model of hips movement (T. Karski – 2006), type and properties of scoliosis

## Materials

In the years 1985 to 2018 it was in observations and in treatment - 2500 children in age 5 to 18 years with problem of scoliosis and other 505 children suspected for scoliosis constituted the control group. The age during examination was the same as indicated above. The children from the control group were presented by parents as ones with the problem of spine deformity but there were with full symmetry of movements of hips, with habit of standing on the left or both legs and in clinical examination (Adams bending test and Lublin side bending test) without any symptoms of scoliosis.

## Biomechanical development of scoliosis

### Sequences of pathological events concerning spine

The scoliosis appears as the secondary deformity originating in the asymmetry of hips' movements. The primary asymmetry of child's body and asymmetry of movement of joints was described by Prof. Hans Mau in articles about Syndrome of Contractures (Figure 1 and 2) [12,24]. This asymmetry has important influence to the function of everybody, but especially of children, because of their growth period of life. Next - these factors in aetiology of scoliosis are: "standing" and "walking".

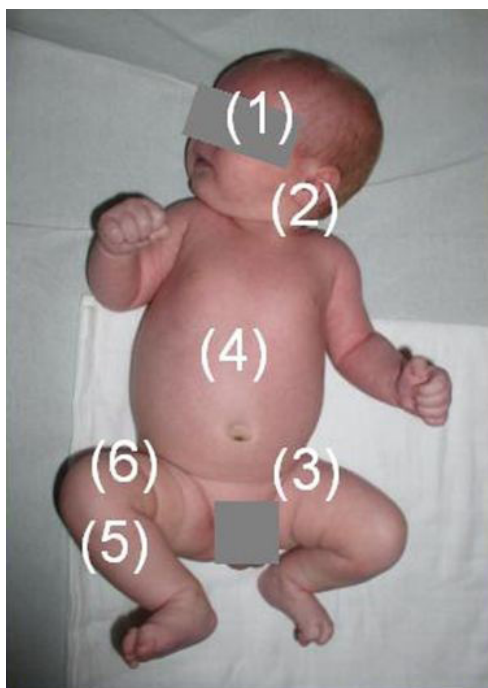
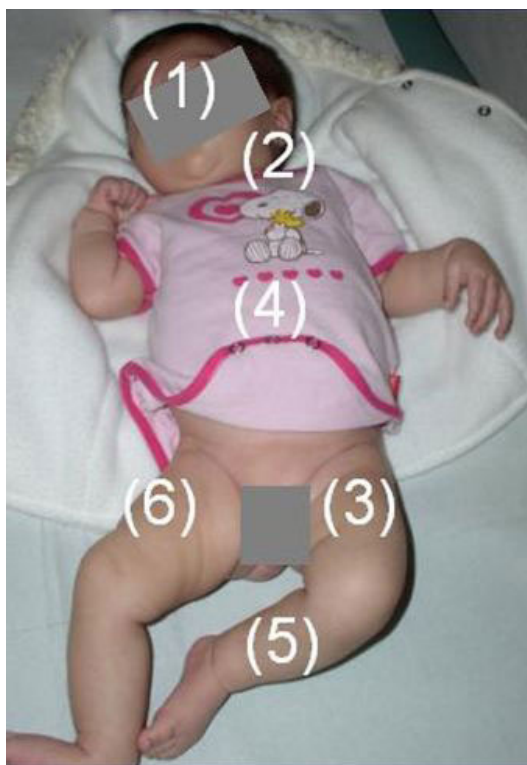


Figure 1: Newborn. Typical clinical symptoms of „Syndrome of Contractures and Deformities” (H. Mau & T. Karski). The symptoms are: (1) plagiocephalia, (2) wry neck, (3) limited abduction of the left hip (later dysplasia), (4) infantile scoliosis, (5) varus of the shanks, (6) limited adduction of the right hip. In such children in next years - through „standing” and „walking” can develop scoliosis

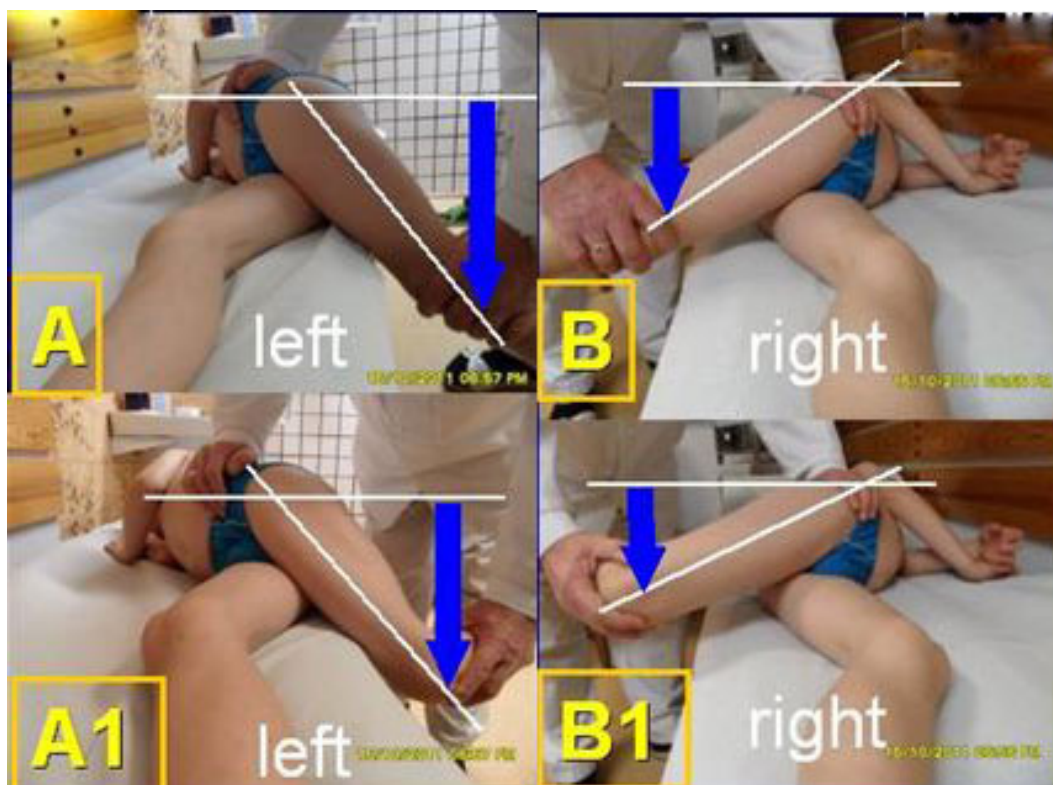
Scoliosis develop – because of walking (explained later) and because of standing ‘at ease’ on the right leg (1995 - 1997 - T. Karski). Start of development of scoliosis is the second year of life. The observations over years proves / confirmed that the right leg is preferred for standing, because such standing is more stable for many children and also for adults and it happened because of smaller adduction, proved / examined in straight position of the joint. Every type of scoliosis starts to develop when the child starts to stand and walk, it's mean in 2<sup>nd</sup> - 3<sup>rd</sup> year of life. Long duration of time of standing on the right leg leads after 8-10 years to fixed scoliosis. There are three group and four types of so-called idiopathic scoliosis.

Depending of types of spine deformity, every type has a special character of patho-morphology and various properties. To explain in details the biomechanical aetiology we must remember about three asymmetries causing the development of scoliosis.



**Figure 2:** Infant. Typical clinical symptoms of "Syndrome of Contractures and Deformities" (H. Mau & T. Karski). The symptoms are: (1) plagiocephalia, (2) wry neck, (3) limited abduction of the left hip (later can be dysplasia), (4) infantile scoliosis, (5) varus of the shanks, (6) limited adduction of the right hip. In such children in next years - through „standing" and „walking" can develop scoliosis

(1) The asymmetry of the movements in the hips. A special important is limited adduction of the right hip, examined in straight position of joint (Figure 3A, 3A1, 3B and 3B1). The limited adduction of right hip is connected additionally with limited internal rotation and very frequent with limited extension. In Table 1 is presented the "model of hips movements" and type of scoliosis as well other properties of spine abnormalities.



**Figure 3A, 3A1, 3B and 3B1:** Test of adduction of hips. One child. Two methods of examination: A & B in extension of the knee, A1 & B1 in flexion of the knee. Difference of adduction of hips typical for „C" II-nd/A or „S" II-nd/B scoliosis

(2) The asymmetry of movement of the hips what is mentioned above is connected with “Seven Contractures Syndrome” described by Professor Hans Mau from Tübingen in Germany in 1960s (in German *Siebenersyndrom*) and then further explained of T. Karski (1995 - 2006) as a “Syndrome of Contractures and Deformity” [25-33].

(3) The limited movement of right hip make influence to the function – “standing” and “gait”. The asymmetrical function of hips, pelvis and spine is the cause of asymmetrical loading during standing and walking. In standing the load is going from foot to pelvis and spine through the right leg. All children with scoliosis has the habit to stand ‘at ease’ only on the right leg. This observation from the 1997 is confirmed by author not only in children in Poland but also in Germany, Austria, Hungary, Czech Republic, China, and Finland. Standing on right leg of patients should be decisive moment in examination by every doctor.

(4) Next influence of development of scoliosis is connected with gait. The gait is an important causative factor in “S” scoliosis I<sup>st</sup> etiopathological group (epg) and in “I” scoliosis (III<sup>rd</sup> epg). Explanation of the role of the gait, in context of new classification, is given in next chapter.

(5) In standing the decisive is time-there is asymmetry of the time while standing ‘at ease’ - longer time on the right leg.

Standing on the right leg is alone one the influences factor in “C” scoliosis

in II<sup>nd</sup> / A (epg) and in “S” scoliosis in II<sup>v</sup> / B epg type of spine deformity. See classification in next chapter.

### The consequential development of the spinal deformity in scoliosis given in points

Firstly I would like to express - what is important and cardinal of knowledge about healthy spine. It happened when the movement of hips is symmetrical - the is no pathological influence on spine and never development so-called idiopathic scoliosis. The children, with normal hip, which has full, symmetrical movement of both joints, they stand the same time on left and right leg, there is also symmetry of loading – left and right side of the body during gait. In such situation never develop scoliosis.

### The scoliosis develop in following stage

1. In development of the so-called idiopathic scoliosis - the asymmetry of hip’s movement play a very important role. Every type of scoliosis depends from the specific “Model of Hips’ Movement” [MofHM] (T. Karski 2006). There are three groups and four types of the spine deformity.

2. The asymmetry of the movement of hips exists in all cases of the so-called idiopathic scoliosis. There is limited adduction, internal rotation and often extension in the right hip. This phenomenon explains “the left side Syndrome of Contractures” according to Prof. Hans Mau (Tübingen, Germany).

3. In gait, a limited movement of adduction, internal rotation of the right hip, is created as “a compensatory movement” and transmitted to the pelvis and to the spine as a secondary process leading to the spine deformity. Consequently, other words, during gait occur by every step a permanent distortion in the inter-vertebral joints and as result it is rotation deformity and later stiffness of the spine. The phenomenon of “the stiffness” we see in cases of “S” I<sup>st</sup> epg and of “I” III<sup>rd</sup> epg group of scoliosis (see - next chapter - classification).

4. The scoliosis “S” in I epg is connected with permanent standing ‘at ease’ on the right leg (the right hip is more stable for standing [!]) and with the gait.

5. The permanent standing ‘at ease’ on the right leg starts, widens and fix the curves - in “C” II<sup>nd</sup> / A epg scoliosis lumbar left convex and in some cases in “S” II<sup>nd</sup> / B epg secondary thoracic right convex curve (see farther chapter about classification). Additional causes of the “S” II<sup>nd</sup> / B epg scoliosis is the laxity of joints (typical for the children with Minimal Brain Dysfunction [MBD]) and also harmful exercises in previous therapy.

6. The scoliosis “I” in III<sup>rd</sup> epg type is connected only with gait. The character of this scoliosis is only the stiffness of the spine. In this deformity there are no curves and no gibbous or there are a very slight. Till now (1995 – 2007) this type of spine deformity was no included to scoliosis group.

7. In all groups of scoliosis in the development of deformity can play an important role the secondary symptoms typical for Minimal Brain Dysfunctions (MBD) and there are:

- a. extensor contracture of trunk, observed even in small children,
- b. anterior tilt of pelvis and in result hiperlordosis of lumbar spine,
- c. laxity of joints (Figure 4a, 4b and 4c).



**Figure 4a, 4b and 4c:** Additional causes in development of so-called idiopathic scoliosis in children with Minimal Brain Dysfunction (MBD). The are: straight position of trunk (Figure 4a), anterior tilt of pelvis and in result hiperlordosis in lumbar spine (Figure 4b), laxity of all joints (Figure 4c) as result of changed collagen

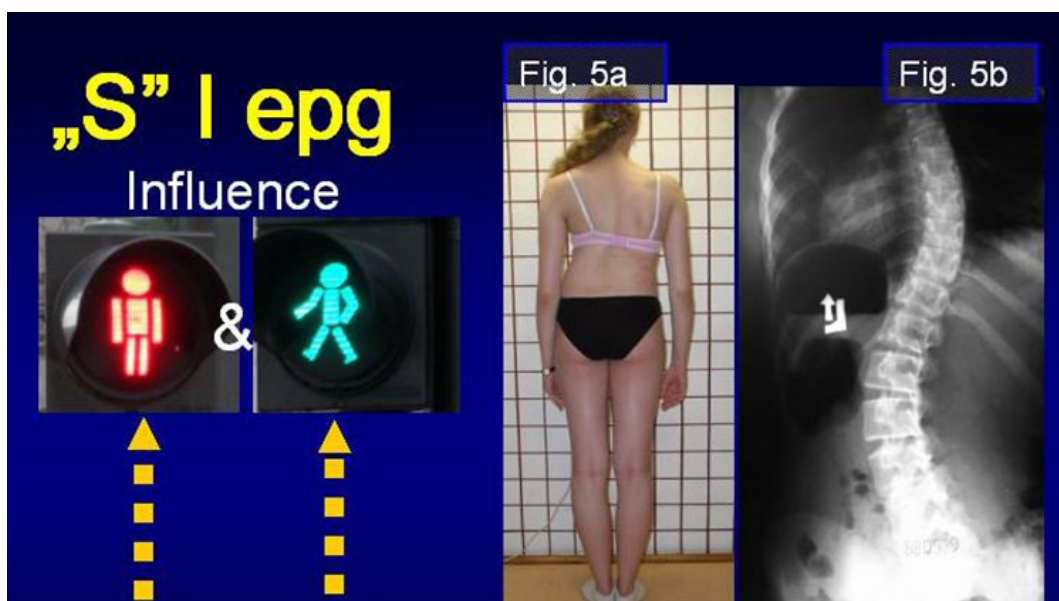
### Classification

“The model of hip movements” and type of scoliosis (Table 1).

When movement of hips, is equal - its mean symmetric of both hips – never develop scoliosis. In such cases there is symmetry of loading of both side of the body during gait and also there is symmetry of time while standing ‘at ease’ on the left and right leg. No act any biomechanical pathological influence on the spine. The spine growing is proper without any pathological changes.

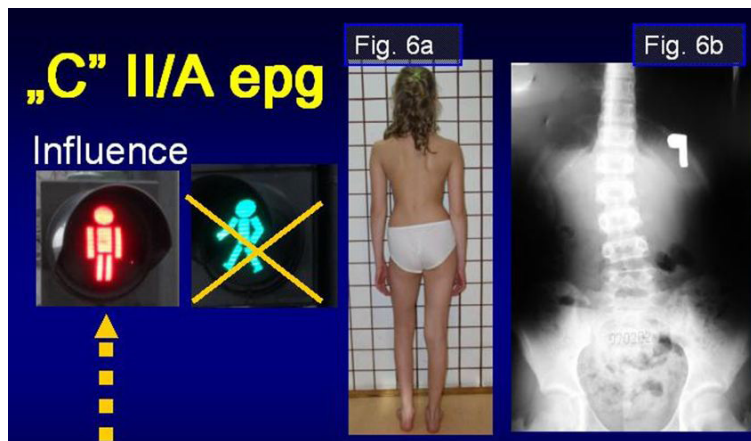
When movement of hips - see model of movements in table, especially adduction in strait position of the joint – and remember - this position is equal to position in standing” and in “stance phase during gait” – is different - left and right sides - there is the input to develop of scoliosis in three groups and four types.

1. “S” double scoliosis (1<sup>st</sup> epg) with stiff spine (3D). Connection with gait and standing ‘at ease’ on the right leg (Figure 5a and 5b).



**Figure 5a and 5b:** Patient in age of 15 years. Scoliosis “S” I epg. Specific „model of hips movement”. The cause of spine deformity – gait and standing ‘at ease’ on the right leg. Two curves. Rib hump. Stiffness. 3D. Progression

2a. "C" (II<sup>nd</sup> / A epg) scoliosis with flexible spine (1D or 2D). Connection only with standing 'at ease' on the right leg (Figure 6a and 6b).



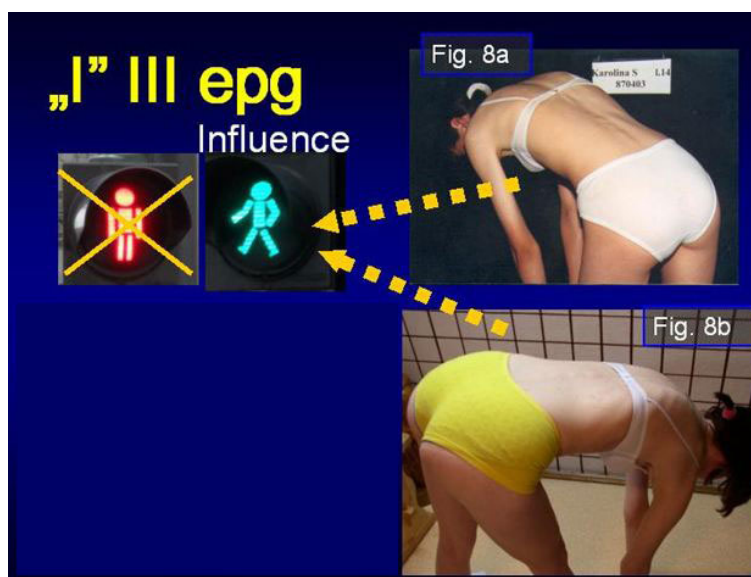
**Figure 6a and 6b:** Patient in age of 12 years. Scoliosis "C" II/A epg. Specific „model of hips movement”. The cause of spine deformity – standing 'at ease' on the right leg. One curve. No stiffness. 1D or 2D. No progression

2b. "S" (II<sup>nd</sup> / B epg) scoliosis (2D or 3D). Connection with standing on right leg and additionally with laxity of joints and / or harmful previous exercises (Figure 7a and 7b). In these both types of scoliosis the spine is flexible.



**Figure 7a and 7b:** Patient in age of 16 years. Scoliosis „S” II/B epg. Specific „model of hips movement”. The cause of spine deformity – standing 'at ease' on the right leg plus general laxity of joints. Two curves. No stiffness. 2D or 3D. No progression or slight

3. "I" (III<sup>rd</sup> epg) scoliosis (2D or 3D) is in form of stiff spine, without curves and without gibbous or with very slight ones. The cause is gait only (Figure 8a and 8b).



**Figure 8a and 8b:** Patient on figure 8a in age of 14, patient on figure 8b in age of 18. Scoliosis „I” III-rd epg. Specific „model of hips movement”. The cause of deformity – only gait. No curves or very slight. Stiffness. 2D or 3D. No progression

## Time of first clinical symptoms of scoliosis and its properties

In new classification there are three groups and four types of scoliosis and every type has own properties / characteristics. Every type of scoliosis starts to develop as mentioned above at the age of 2 or 3.

Scoliosis “S” in I epg group is to see as disappearing of processes spinosi in thoracic part of spine and as stiffness of spine in age of 4 – 6 years. Next develop curves.

Scoliosis “C” II/A epg and “S” II/B epg is to see in age 8 - 12 years.

Scoliosis “I” III epg till 1995-2007 - in old classification was never included to scoliosis deformity, because the symptoms were only stiffness and not curves of the spine. This type of scoliosis makes problem in sport of youth people and back pain problems in adults.

## Discussion and comments to the new classification

The founded aetiology of the so-called idiopathic scoliosis answer all questions connected to the spine deformity: time of beginning of development of scoliosis, time of the first clinical symptoms of deformity, sides of curves, sided of gibbous, problem of progression, is giving also the new classification and information about causal prophylaxis and therapy. The classification informs that “S” scoliosis in I<sup>st</sup> etiopathological group can be diagnosed very early, at the age of 3 - 4. The author observed that children which should theoretically in future deserve to the I<sup>st</sup> group of scoliosis - aged 1 year - which start to walk and can stand independently, stand mostly ‘at ease’ on the right leg (last observation in Out – Patient Clinic). For every doctor and for parents “the fact of standing on the right leg” should be an alarming sign indicating / showing the danger of the scoliosis.

In the “S” scoliosis in I<sup>st</sup> epg group, the first clinical sign is the rotation deformity which should warn against spinal deformity. In some cases of the I<sup>st</sup> epg group the first sign of scoliosis is disappearing of processes spinals 6<sup>th</sup> to 12<sup>th</sup>, stiffness and in older children even “lordotic deformity in thoracic spine” - especially after improper exercises. The properties of such scoliosis are: progression, especially during the acceleration period of growth and bigger deformity after harmful exercises.

The “C” scoliosis in II<sup>nd</sup> / A epg and “S” scoliosis in II<sup>nd</sup> / B epg can be diagnosed at the age of 8 - 12. The cause is only - the habit of permanent standing ‘at ease’ on the right leg for many years. Initially, it is only the lateral deviation of the spine, then with years fixed in “C” left convex curve. In the development of the “S” II<sup>nd</sup> / B epg scoliosis, occurs additionally, what I mentioned above - the laxity of joints (see symptoms according Wynne – Davies) and / or harmful exercises. In some cases of “S” II<sup>nd</sup> / B epg group we observe in children kypho (kifo) -scoliosis.

The “C” and “S” scoliosis because of permanent standing over years on the right leg can be the cause of degenerative scoliosis in adults people with clinical symptoms of “low back pain” (Figure 9).

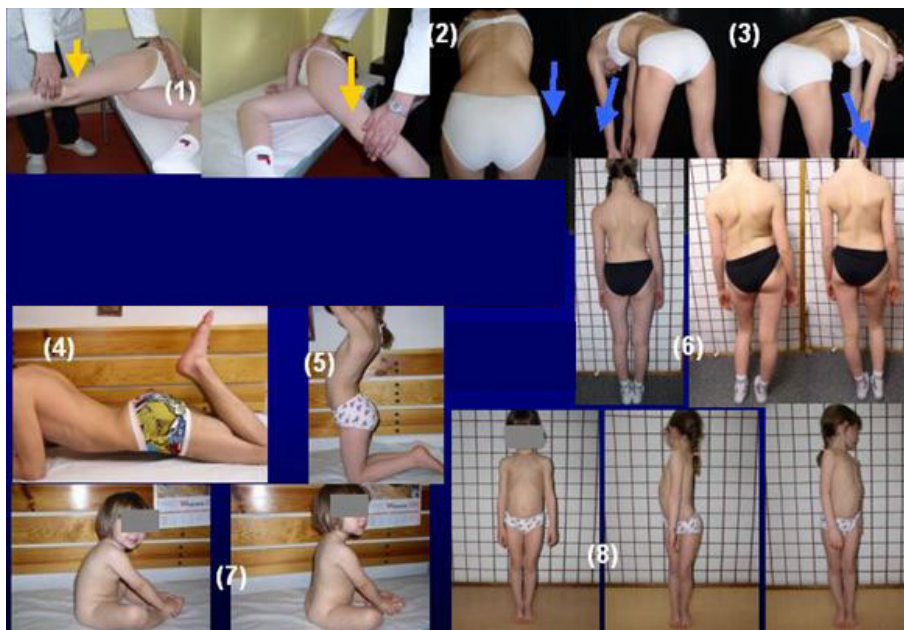


**Figure 9:** Example of „C” II-nd / A degenerative lumbar left convex scoliosis. Female patient – 66 y. Problems: back pain since 8 years with radiation to left leg. Transient “paretic equinus deformity of left foot”. Patient had the habit to stand ‘at ease’ only on the right leg. Examination: specific model of hip movements. Adduction of the right hip (in straight position) 20/15 degree, of left hip 40/35 degree. X-ray picture – view from back

The “I” scoliosis in III<sup>rd</sup> epg (as mentioned above - this etiopathological group is introduced to new classification in 2004) – there is a spine deformity with little or no curvature – but with loss of flexibility of the spine and next with completely stiffness of the spine, in the 6<sup>th</sup>-12<sup>th</sup> part particularly visible. The cause of this spine deformity is connected only with the gait. In gait due to a restricted movement of right hip – adduction and internal rotation and with a small these movements in the left hip, a compensatory rotation movement in the pelvis and spine is created. This compensatory movement makes, as mentioned above, a permanent distortion in the inter-vertebral joints which result in stiffness and rigidity of the spine. The stiffness of the spine can be observed in adolescents. However, nobody considered this to be scoliosis. These patients, when adult - often suffer because of back pain. About this group “scoliosis without scoliosis” was my discussion in Hong Kong (2004).

### The possibility of causal prophylaxis of scoliosis

The new screening and new classification clarifies the need for therapeutic approach to each etiopathological type of scoliosis and provides the possibility to introduce causative prophylaxis (Figure 10). Here is necessary to express, that the “C” and “S” scoliosis in II<sup>nd</sup> / A / B epg group, by adults people, because of the permanent standing ‘at ease’ on the right leg over years, become to be “degenerative scoliosis”, the one of the causes of “the back pain”.



**Figure 10:** New tests in scoliosis examination to find asymmetry in position & function of joints. Scoliosis screening tests: (1) Adduction test (Ober test), (2) Adams test, (3) Lublin test, (4) Ely Duncan (Thom, Staheli) test, (5) Kneeling test, (6) Standing test, (7) Sitting test, (8) Rotation of pelvis test

Because of this - the causal prophylaxis and new treatment is very important. In problem of therapy I must put your attention, that all strengthening, extension exercises, which were made in past time in many countries, were only harmful. After such extension exercises the curves were only bigger, the rib hump more expressed and the stiffness of spine more fix. The progression of deformity was huge and explained by doctors as “the nature history of scoliosis”. This term I quote from old book about scoliosis. So was in past time the explanation of the wrong result of therapy. The new knowledge inform - the bad result of therapy were because of incorrect method of treatment (see Literature-article of author), but not because of a “specific character of scoliosis”.

To all children and adolescent endangered with scoliosis or just with first symptoms of scoliosis should be introduced the simple and profitable method of therapy (Figure 11).

The principles of new treatment for all children are as following:

1. No more stand “at ease” on the right leg,
2. Sit relax,
3. Sleep in embryo position,
4. Makes intensive sport, also in schools – especially stretching and bending exercises for spine, to receive the symmetry of movements of both hips, symmetry of position of pelvis, to remove the anterior tilt of pelvis and to receive full movements – flexion, deviation and rotation of the spine,
5. Especially profitable are such sport arts like karate, taekwondo, aikido, kung fu, yoga and other similarly,
6. Especially important is to receive the full movement of right hip. It should be the new aim for physiotherapy. For this aim – stretching exercises should be made permanently, every day – as long as will be received full range of movement,
7. In some causes – in I-st epg scoliosis can be useful corset,
8. The therapy should be continued to 15-18 year of life - so long as the child growth up and in some cases longer.



9. Also older people – without scoliosis from childhood period - should remember do not stand on the right leg – because it can lead to “degenerative scoliosis” and arthrosis of the right hip.



Figure 11: Proper prophylactic and therapeutic exercises for scoliosis

## Conclusions

1. In 34 years (1984-2018) of observations I can, in all examined cases, confirmed the biomechanical aetiology of the so-called idiopathic scoliosis.
2. Development of scoliosis and type of spine deformity is connected with pathological “model of hips movements” (T. Karski, 2006) and function - standing ‘at ease’ on the right leg and walking.
3. There are three groups and four types of scoliosis:
  - “S” scoliosis I st epg, 3D. Causative influence: standing and gait,
  - “C” scoliosis II nd / A epg, 1D. Causative influence: standing,
  - “S” scoliosis II nd / B epg, 1D or 2D. Causative influence: standing, plus laxity of joints and/or incorrect exercises in previous therapy,
  - “I” scoliosis III rd epg, 2D or 3D. Clinically only stiffness of spine. Causative influence: gait.
4. Every type of scoliosis starts to develop in age of 2-3 years.
5. Both - the old tests (Adams & Meyer test) but also the new tests should be used for early screening.
6. The new tests include:
  - a. “Lublin side bending test” – more sensible as Adams – Meyer test,
  - b. Checking of the habit of standing ‘at ease’ (right versus left leg),
  - c. Ely Duncan test (or Thom or Staheli test),
  - d. Adduction of hips test (similarly to Ober test), and other - see literature of author and especially website [www.ortopedia.karski.lublin.pl](http://www.ortopedia.karski.lublin.pl)
7. In every country should be introduce the causal prophylaxis of scoliosis by using the new therapy - stretching exercises for hips, pelvis, spine plus standing only on left leg, rest and sleeping in embryo position. Very important are stretching arts of sport.

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